Annals of Agricultural Science, Moshtohor (ASSJM)
https://assjm.journals.ekb.eg/
www.fagr.bu.edu.eg
© 2023, Faculty of Agriculture, Benha University, Egypt. ISSN:1110-0419
Original Article Vol. 62(1) (2024), 57 – 66 DOI: 10.21608/assjm.2024.285941.1279

Evaluation the Growth, Some Chemical Constituents and Landscape Value of *Alternanthera Dentata* Plant Grown Under Different Planting Methods and Distances with Herbaceous Plants

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Abstract

This investigation was carried out during the two successive seasons of 2020/2021 and 2021/2022 in the Experimental farm of Hort. Dept., Fac. Agric. at Moshtohor, Benha Univ., Egypt. This study aimed to the effect of different cultivation methods (row and alternating planting) and planting distances (30 and 50 cm) with some herbaceous plants and their interactions on growth, chemical compositions and landscape use of *Alternanthera dentata* for using to landscaping the public gardens. The obtained results referred to that alternating *Centaurea cineraria* replaced with *Lettuce sativa* then replaced with *Zinnia elegans* under 30 cm spacing gave the highest values in plant height, herb fresh weight and branches number per *Alternanthera dentata* plant.Also, the highest N, P, K and carbohydrates percentages produced when *Alternanthera* plant alternated by *Polyanthus rosa* under 50 cm spacing. Planting *Alternanthera* as rooted cuttings as row planting at 50 cm spacing significantly increased leaves number per plant, herb fresh weight and branches number per plant compared to the other combinations under study. Alternating *Brassica oleracea var. capitata* then *Zinnia elegans* at 30 cm spacing recorded the highest values in N, P, K and carbohydrates percentages of *Alternanthera dentata* plant. It is clear that the overall trend of the questionnaire towards the general form when *Alternanthera dentata* plants cultured with different herbaceous plants was 26.7 % preferred, 56.7 % to most extent and 16.7 % not preferred.

Key words: *Alternanthera dentata*, cultivation method, spacing, growth, chemical and landscape

Introduction

Ornamental and vegetable plants contribute to the urban environment in various ways, for example minimizing releasing moisture, air pollution, conserving energy through balancing temperatures and providing habitats for flora and fauna **(Akbari *et al.*, 2001).** Furthermore, plants also reduce the negative influences of dust, greenhouse gases and wind **(Novak and Crane, 2002)**, as well as noise control (**Walker, 1991)** and decrease light reflection **(Heisler and Grant, 2000)** in a private and public gardens.

Amaranthaceae is the family to which *Alternanthera dentata* L. plants belong. White tiny flowers grow in clusters on this evergreen perennial shrub. The plant may be grown in pots and is used as a tiny hedge plant. It's simple, opposite-leafed leaves have a purple hue, and its natural colored pigments are inexpensive, readily available, and environmentally beneficial (**Nair and Sheetal, 2011**).

A subshrub is *Centaurea cineraria*. It is a species in the family Asteraceae and genus *Centaurea* or *Senecio*, which together comprise between 1562 and 2834 species. The plant is between 40 and 60 cm hieght. More than its yellow blooms, its lovely silver-gray leaves are why it is grown. To promote leaf growth, most gardeners really prefer to trim off the blossoms. Although the plant is frequently cultivated in formal bedding schemes, it also looks good in more casual or cottage-style arrangements. Dusty Miller produces a lovely edging and is a great complement to a vibrant container garden (**Christoper, 2003**).

Zinnia elegans, native to Mexico, *Zinnia elegans*, Jacq., is an annual summer flowering plant in the Asteraceae family. The plants have an erect, bushy form with leaves that are up to 8 cm long, oblong to lance-shaped, and slightly hairy. Summer yields broad-petaled purple flower heads, up to 4.5 cm in diameter, which resemble daisies. It expands rather quickly, reaching a height of 60–75 cm and a width of 30 cm. *Zinnias* are grown for their terminal flower heads, which are solitary, long-stemmed, and resemble daisies. They come in a variety of hues, such as white, yellow, orange, red, purple, and lilac, and some even have eyes that contrast with one

another. Zinnia plants are useful for cutting as well as in an annual or mixed border. Smaller cultivars work well in window boxes or pots, as well as for edging (**Mills-Hicks, 2007**; **Brickell, 1997**).

Polyanthus rosa is a member of the Rosaceae family, which is also referred to as the Rose family. This species is significant since it provides food as well as beautiful trees and shrubs. With the exception of the Arctic, the family's more than 90 genera and 3500 species are extensively scattered around the globe (**Xiang *et al.*, 2017**). Furthermore, *Polyantha* is the foundation flower in a lot of gardens all around the world. Fairy roses are a significant polyantha rose class that were initially introduced as garden roses in the 1930s (**Dadhwal, 2016**).

One of the most significant leafy vegetables, lettuce (*Lactuca sativa* L.) is an annual plant that belongs to the aster family, Asteraceae. It is typically consumed raw or in salads (**Labeda *et al.*, 2007**; **Chiesa *et al.*, 2009**). Due to its high phytonutrient content, high vitamin K and A contents, beta-carotene content, fiber content, phenolic compounds, and minerals like calcium, phosphorus, potassium, manganese, and iron, this vegetable is said to offer a number of health benefits (**Mulabagal *et al.*, 2010**; **Xylia *et al.*, 2021**).

Because of the different shapes and colors of their inner leaves, some varieties of cabbage are grown for aesthetic purposes; these are known as ornamental cabbages. Flower beds are where they are planted in gardens and parks. They are also used in floral design and floristry. Because they are at their most decorative throughout the fall, they are ideal for decorations. It is remarkable how well they withstand low temperatures. Most people think that *Brassica oleracea* L. var. Acephala Auct. is the source of cabbage cultivars that form a rosette of colored leaves; however, some people think that *Brassica oleracea* L. var. Capitata L. and savoy cabbage *Brassica oleracea* L. var. Sabauda L. are also possible sources (**Whipker *et al.*, 1998**; **Chmiel, 2000**; **Liu *et al.*, 2017**).

A significant factor influencing growth and yield-contributing characteristics that can be adjusted to optimum growth and development is plant spacing. The amount of incident solar radiation and its conversion to chemical energy determine how much dry matter a crop can produce. The arrangement and orientation of leaves within the canopy affect a crop's ability to capture and transform solar radiation (**Siddappa *et al.*, 2018**). Achieving the target yield requires both optimal density and row spacing (**Khenizy *et al.*, 2014**).

One of the most crucial techniques in design studies is the use of questionnaires, which guarantee that the questions are answered clearly (**Al-Asadi and Al-Samarrai, 2022**). A three-point Likert scale was used to create a questionnaire form with evaluation criteria (**Likert, 1932**).

The present study was undertaken to determine the optimum planting distances and cultivation methods of *Centaurea cineraria*, *Zinnia elegans*, *Polyanthus rosa*, *Lactuca sativa* and *Brassica oleracea* L. var. Capitata –as border plants- on growth, chemical constituents and landscape value of *Alternanthera dentata* as filler plant in order to obtain plants with good quality as well as better landscape value to be utilized in future cultivation.

Materials and methods

This investigation was carried out during two successive seasons of 2020/2021 and 2021/2022 in the Experimental farm of Hort. Dept., Fac. Agric. at Moshtohor, Benha Univ., Egypt to study the effect of different planting distances and cultivation methods on growth, chemical composition and landscape use of some herbaceous plants for using to landscaping the public gardens.

Plant materials

The seedlings of plants which used in this experiment were taken from Floriculture nursery of Hort. Dept., Fac. Agric. at Moshtohor, Benha Univ. in uniform size and length. The plants were: *Polyanthus rosa* rooted cuttings in uniform size and length (33 cm long with long with 50-52 pairs of leaves and 13 branches). *Alternanthera sp.* seedlings in uniform size and length (34 cm long with 15-16 pairs of leaves and 4 branches) were used. *Centaurea cineraria* seedlings in uniform size and length (18 cm long with 9-20 pairs of leaves) were utilized. *Lactuca sativa* var. Capitata seedlings in uniform size and length (14 cm long with 3-4 pairs of leaves at 20 days old) were used. *Brassica oleracea* var. capitata f. rubra seedlings in uniform size and length (15 cm long with 3-4 pairs of leaves at 20 days old) were utilized. *Coriandrum sativum* seeds were obtained from Hort. Dept., Fac. Agric. at Moshtohor, Benha Univ. *Zinnia elegans* seedlings in uniform size and length (29 cm long with 5-6 pairs of leaves) were used. *Lactuca sativa* seedlings in uniform size and length (20cm long with 3-4 pairs of leaves at 20 days old) were utilized.

The seedlings of different plants which used in the current experiment were transplanted in clay loam soil in experimental plots at 20th and 23rd October during 2021/ 2022 and 2022/2023 respectively. All other horticultural practices were done as needed and adding recommended doses of fertilizer (1N:2P:1K) at 4g/ plant. The physical and chemical properties of experimental soil were determined according to (**Chapman and Pratt, 1978**) and presented in Table 1.

Table 1. Experimental soil physical and chemical properties (average of 2021/2022 and 2022/2023 seasons)

Physical properties											Soil Texture
Course sand %		Fine sand %		Silt %		Clay %					Clay
7.33		5.60		33.50		53.57					
Chemical properties											
E.C	HCo_3	Cl	So_4	Ca	Mg	Na	Available (ppm)				
							K	N	P	Fe	Mn	Zn
0.62	2.00	3.4	0.80	2.50	1.20	1.27	1.23	918.7	17.9	9411.1	450.1	72.43

Also, the results of water analyses of tap water are presented in Table 2 and analyzed in the desert Research Center Laboratory according to **Rainwater and Thatcher (1960)**.

Table 2. Water analyses of the tap water (control)

PH	E.C.	Soluble cations (mmlc L^{-1})				Soluble anions (mmolc L^{-1})			
	(ds m^{-1})	Ca++	Mg++	Na+	K+	CO_3^-	HCO_3^-	SO_4^-	Cl^-
7.1	0.42	1.43	1.32	1.47	0.20	0.00	2.49	0.79	1.14

Layout of the experimental:

The experiment was factorial arranged in a split plot design with three replicates. The main plots were occupied with two cultivation methods (rows or alternative hills shape), while planting distances (30 or 50 cm) were distributed in the subplots.

Data recorded:

For both seasons the following data were recorded on *Alternanthera sp.* Plants after 86 days from transplanting date:

Vegetative growth

Plant height (cm), number of leaves and branches per plant and herb fresh weight per plant (g) were recorded.

Chemical constituents:

In the dry leaves, total nitrogen, total phosphorus and potassium percentages were determined according to that reported by **A.O.A.C. (2005)**. Also, total carbohydrates percentage was determined in the same sample according to **Dubois *et al.* (1960)**.

Questionnaire evaluate and analysis

Questions were selected that fit the reality of the study and were evaluated linguistically and scientifically by specialists in (landscape gardening) to appear in a way that achieves its purpose.

Questionnaire analysis:

Individual interviews were conducted with specialized experts. The data were dumped manually into Microsoft Excel 2010. Responses percentage was calculated. The number of responses is equal to the total number of respondents for the different planting methods and distances.

Statistical analysis:

The experiment was factorial arranged in a split plot design with three replicates accordance with **Gomez and Gomez (1984)**, data analysis was done. Means were differentiated at the 5% probability level using the least significant difference (LSD). The Statistix version 9 (**Analytical Software, 2008**) computer application was used to compare the means.

Results and Discussion

Effect of planting methods

Table 3 reveals that alternating *Centaurea cineraria* and replaced it with *lettuce sativa* then replaced with *zinnia* with *Alternanthera dentate* significantly increased plant height and number of branches per plant compared to row planting methods. While, different planting methods no significantly affected number of leaves per plant and total fresh weight of herb in both seasons. Furthermore, the highest number of branches and leaves per *Alternanthera* plant values were achieved when *Rosa polyanthus* plants alternating with *Alternanthera dentate* plants compared to row method (Table 4). Alternating *Lettuce capitata var. capitata* then *coriander sativum* then *lettuce sativa* with *Alternanthera dentate* significantly increased *Alternanthera* height and number of leaves per plant with no significant difference regard herb fresh weight compared to row method during 1st and 2nd seasons (Table 5). Planting *Brassica oleracea* var. *Capitata sub.* var. *rubra* plants then replaced with *Zinnia elegans* as row method with *Alternanthera dentate* significantly improved plant height as well as number of branches and leaves per plant compared to alternating planting method (Table 6).

Using alternating method by *Centaurea cineraria* and replaced it with *lettuce sativa* then replaced with *zinnia* or alternating *Polyanthus rosa* only with *Alternanthera dentate* significantly increased N, P, K and total carbohydrates percentages of *Alternanthera* plants compared to row planting pattern during the two seasons (Tables 7 and 8).

Table 3. Effect of planting methods , distances and their interaction treatments of *Centaurea cineraria* replaced with *lettuce sativa* then replaced with *zinnia* on growth of *Alternanthera dentate* (average of both seasons)

Treatments		Plant height (cm)	Number of branches/plant	Number of leaves/plant	Herb fresh weight/plant (g)
		Effect of planting methods			
Row planting		72.08	12.16	258.75	114.24
Alternating planting		73.66	13.91	258.16	117.00
L.S.D. at 5 %		**1.44**	**0.21**	**N.S.**	**N.S.**
		Effect of planting distances			
30 cm		77.58	13.99	252.25	115.33
50 cm		68.16	12.08	264.66	115.91
L.S.D. at 5 %		**2.57**	**1.23**	**0.67**	**N.S.**
		Effect of interaction between planting methods × distances			
Row planting	**30 cm**	74.49	11.16	220.33	112.99
	50 cm	69.66	13.16	297.16	115.49
Alternating planting	**30 cm**	80.66	16.83	284.16	117.66
	50 cm	66.66	10.99	232.16	116.33
L.S.D. at 5 %		**2.90**	**1.24**	**14.69**	**3.99**

Table 4. Effect of planting methods , distance and their interaction treatments of *Rosa polyanthus* on growth of *Alternanthera dentate* (average of both seasons)

Treatments		Plant height (cm)	Number of branches/plant	Number of leaves/plant	Herb fresh weight/plant (g)
		Effect of planting methods			
Row planting		76.99	12.91	256.63	117.16
Alternating planting		71.49	13.66	258.74	113.91
L.S.D. at 5 %		**1.65**	**0.62**	**1.26**	**N.S.**
		Effect of planting distances			
30 cm		74.74	14.08	227.63	114.49
50 cm		73.74	12.49	287.74	116.58
L.S.D. at 5 %		**N.S.**	**1.49**	**3.05**	**0.132**
		Effect of interaction between planting methods × distances			
Row planting	**30 cm**	80.99	11.83	219.77	116.49
	50 cm	72.99	13.99	293.49	117.83
Alternating planting	**30 cm**	68.49	16.33	235.49	112.49
	50 cm	72.99	10.99	281.99	115.33
L.S.D. at 5 %		**2.61**	**1.60**	**3.28**	**3.93**

Table 5. Effect of planting methods , distances and their interaction treatments of *Lettuce capitata var. capitata then Coriander sativum then lettuce sativa* on growth of *Alternanthera dentate* (average of both seasons)

Treatments		Plant height (cm)	Number of branches/plant	Number of leaves/plant	Herb fresh weight/plant (g)
		Effect of planting methods			
Row planting		78.33	15.33	254.92	111.25
Alternating planting		85.49	13.49	228.66	114.66
L.S.D. at 5 %		**0.41**	**0.82**	**6.82**	**N.S.**
		Effect of planting distances			
30 cm		81.08	8.83	175.17	71.41
50 cm		82.74	19.99	308.41	154.50
L.S.D. at 5 %		**N.S.**	**0.38**	**1.08**	**0.48**
		Effect of interaction between planting methods × distances			
Row planting	**30 cm**	73.49	9.50	188.00	68.00
	50 cm	83.16	21.16	321.83	154.49
Alternating planting	**30 cm**	88.66	8.16	162.33	74.83
	50 cm	82.33	18.83	294.99	154.49
L.S.D. at 5 %		**4.19**	**0.89**	**6.88**	**5.19**

Table 6. Effect of planting methods , distances and their interaction treatments of *Brassica oleracea* var. *capitata* sub.var. *rubra* then *Zinnia elegans* on growth of *Alternanthera dentate* (average of both seasons)

Treatments		Plant height (cm)	Number of branches/plant	Number of leaves/plant	Herb fresh weight/plant (g)
		Effect of planting methods			
Row planting		76.58	15.66	275.33	114.83
Alternating planting		72.16	11.24	238.66	129.00
L.S.D. at 5 %		**3.52**	**0.21**	**1.65**	**1.65**
		Effect of planting distances			
30 cm		69.41	14.99	294.33	118.33
50 cm		79.33	11.91	219.66	125.50
L.S.D. at 5 %		**1.42**	**1.23**	**2.39**	**1.89**
		Effect of interaction between planting methods × distances			
Row planting	**30 cm**	71.33	19.49	329.00	115.50
	50 cm	81.83	11.83	221.66	114.16
Alternating planting	**30 cm**	67.49	10.49	259.66	121.16
	50 cm	81.83	11.99	217.66	136.83
L.S.D. at 5 %		**3.74**	**1.24**	**2.85**	**2.46**

Table 7. Effect of planting methods, distances and their interaction treatments of *Centaurea* replaced with *lettuce sativa* then replaced with *zinnia* on chemical constituents of *Alternanthera dentate* (average of both seasons)

Treatments		Nitrogen (%)	Phosphorus (%)	Potassium (%)	Total carbohydrates (%)
		Effect of planting methods			
Row planting		1.437	0.140	1.215	8.747
Alternating planting		1.532	0.147	1.407	11.477
L.S.D. at 5 %		**0.023**	**0.001**	**0.031**	**0.002**
		Effect of planting spacing			
30 cm		1.478	0.138	1.282	9.550
50 cm		1.490	0.149	1.340	10.673
L.S.D. at 5 %		**N.S.**	**0.001**	**0.025**	**0.854**
		Effect of interaction between planting methods × spacing			
Row planting	**30 cm**	1.413	0.135	1.190	8.040
	50 cm	1.460	0.144	1.240	9.453
Alternating planting	**30 cm**	1.543	0.141	1.373	11.060
	50 cm	1.520	0.153	1.440	11.893
L.S.D. at 5 %		**0.028**	**0.004**	**0.039**	**0.854**

Table 8. Effect of planting methods, distances and their interaction treatments of *Rosa polyanthus* on chemical constituents of *Alternanthera dentate* (average of both seasons)

Treatments		Nitrogen (%)	Phosphorus (%)	Potassium (%)	Total carbohydrates (%)
		Effect of planting methods			
Row planting		1.437	0.144	1.392	10.913
Alternating planting		1.572	0.156	1.530	11.898
L.S.D. at 5 %		**0.025**	**0.0012**	**0.019**	**0.869**
		Effect of planting spacing			
30 cm		1.470	0.146	1.425	10.703
50 cm		1.538	0.155	1.497	12.108
L.S.D. at 5 %		**0.007**	**0.0013**	**0.043**	**1.187**
		Effect of interaction between planting methods × spacing			
Row planting	**30 cm**	1.390	0.139	1.340	9.943
	50 cm	1.483	0.149	1.443	11.883
Alternating planting	**30 cm**	1.550	0.152	1.510	11.463
	50 cm	1.593	0.160	1.550	12.333
L.S.D. at 5 %		**0.026**	**0.0018**	**0.047**	**1.445**

Again, alternating *Alternanthera dentate* by *Lettuce sativus var capitita* then *coriander* then *lettuce sativus* significantly enhanced chemical constituents of *Alternanthera* plants compared to row method (Table 9). Moreover, nitrogen, phosphorus and potassium percentages of *Alternanthera* significantly increased when *Brassica* then *zinnia* planting as alternating method *Alternanthera dentate* compared to row planting method during both season (Table 10).

Combination cropping, as opposed to sole cropping, produces optimal crop growth, according to **Thavaprakash *et al.* (2005)**. This is one of the key elements for increased production since it makes better use of the various subsurface resources and maximizes solar radiation harvesting, both of which improve plant growth. **Mohammed *et al.* (2021)** they noticed that when one row of roselle was planted in place of three rows of cluster beans, the roselle growth traits and its chemical constituents significantly enhanced as compared to the other planting methods that were being studied.

Effect of planting distances

As shown in Table 3 illustrated that planting *Alternanthera dentate* at wide distance (50 cm) with *Centaurea* replaced with *lettuce sativa* then replaced with *zinnia* significantly enhanced plant height and number of branches per plant compared to narrow distance during both seasons. Planting *Alternanthera dentate* with *Rosa polyanthus* at 50 cm distance significantly increased number of leaves per plant and herb fresh weight compared to 30 cm distance (Table 4). Generally, all growth parameters of *Alternanthera dentate* plants significantly increased by using 50 cm planting distance when the plants gathered with *Lettuce capitata* var. *capitata* then replaced with *Coriander sativum* then *lettuce sativa* (Table 5). Culturing *Alternanthera dentate* plants with *Brassica oleracea* var. *Capitata* sub var. *rubra* then replaced by *Zinnia elegans* at 30 cm distance significantly increased number of leaves and branches per plant compared to 50 cm distance (Table 6).

Moreover, using 50 cm distance for planting *Alternanthera dentate* plants with *Centaurea* replaced with *lettuce sativa* then replaced with *zinnia* significantly increased phosphorus, potassium and total carbohydrates percentages compared to 30 cm distance (Table 7). All chemical constituents estimated under study of *Alternanthera dentate* plants significantly increased by using 50 cm planting distance when the plants gathered with *Rosa polyanthus* (Table 8). Phosphorus and potassium percentages of *Alternanthera dentate* plants significantly increased when cultured at 50 cm distance with *Lettuce capitata* var. *capitata* then replaced with *Coriander sativum* then *lettuce sativa* or *Brassica oleracea* var. *Capitata* sub. var. *rubra* then replaced by *Zinnia elegans* (Tables 9 and 10).

Based on an analysis of the studied *Lachenalia* cultivars, a general conclusion can be made that, in most situations, the length of the leaf blade reduces while the width grows as the distance between bulbs increases during planting. Competition for light may lead to longer and narrower leaves (**Kapczyńska, 2013**). In addition, **Jena and Mohanty (2021)** reported that annual *Chrysanthemum* plants grown under the closest spacing 30cm × 30 cm gave the minimum values of plant spread and number of leaves per plant.

Table 9. Effect of planting methods, distances and their interaction treatments of *Lettuce sativus* var. *capitita* then *coriander* then *lettuce sativus* on chemical constituents of *Alternanthera dentate* (average of both seasons)

Treatments		Nitrogen (%)	Phosphorus (%)	Potassium (%)	Total carbohydrates (%)
		Effect of planting methods			
Row planting		1.405	0.143	1.215	9.862
Alternating planting		1.537	0.157	1.310	11.692
L.S.D. at 5 %		**0.106**	**0.002**	**0.012**	**0.236**
		Effect of planting spacing			
30 cm		1.465	0.148	1.245	9.607
50 cm		1.477	0.152	1.280	11.947
L.S.D. at 5 %		**N.S.**	**0.0015**	**0.008**	**0.378**
		Effect of interaction between planting methods × spacing			
Row planting	**30 cm**	1.400	0.136	1.190	8.880
	50 cm	1.410	0.150	1.240	10.843
Alternating planting	**30 cm**	1.530	0.160	1.300	10.333
	50 cm	1.543	0.153	1.320	13.050
L.S.D. at 5 %		**0.108**	**0.002**	**0.015**	**0.438**

Table 10. Effect of planting methods and spacing and their interaction treatments of *Brassica then zinnia* on chemical constituents of *Alternanthera dentate* (average of both seasons)

Treatments		Nitrogen (%)	Phosphorus (%)	Potassium (%)	Total carbohydrates (%)
		Effect of planting methods			
Row planting		1.497	0.145	1.242	11.305
Alternating planting		1.560	0.158	1.405	11.637
L.S.D. at 5 %		**0.031**	**0.009**	**0.031**	**N.S.**
		Effect of planting spacing			
30 cm		1.537	0.151	1.282	11.720
50 cm		1.520	0.162	1.365	11.222
L.S.D. at 5 %		**N.S.**	**0.006**	**0.048**	**N.S.**
		Effect of interaction between planting methods × spacing			
Row planting	30 cm	1.443	0.141	1.223	10.660
	50 cm	1.550	0.148	1.260	11.950
Alternating planting	30 cm	1.630	0.160	1.340	12.780
	50 cm	1.490	0.155	1.340	10.493
L.S.D. at 5 %		**0.057**	**0.012**	**0.055**	**1.747**

Effect of planting methods × planting distances

Tables 3 demonstrates that alternating *Centaurea* replaced with *lettuce sativa* then replaced with *Zinnia elegans* under 50 cm spacing gave the highest values in fresh and dry weight of roots per plant. In addition, alternating *Rosa polyanthus* under 30 cm spacing gave the highest values in herb fresh and dry weights and branches number per *Alternanthera dentata* plant (Table 4). Number of branches and leaves per plant and herb fresh weight of *Alternanthera dentate* plants significantly increased by using 50 cm planting distance when the plants gathered with *Lettuce capitata* var. *capitata* then replaced with *Coriander sativum* then *lettuce sativa* as row planting method during both seasons (Table 5). Culturing *Alternanthera dentate* plants with *Brassica oleracea* var. *Capitata* sub var. *rubra* then replaced by *Zinnia elegans* as row planting method at 30 cm distance significantly increased number of leaves and branches per plant compared to the other combination treatments (Table 6).

Alternating *Centaurea* plants then replaced with *lettuce sativa* then replaced with *Zinnia elegans* under 50 cm spacing gave the highest values of P, K and total carbohydrate percentages (Table 7). All chemical constituents estimated under study of *Alternanthera dentate* plants significantly increased by using 50 cm planting distance when the plants alternating with *Polyanthus rosa* (Table 8). Nitrogen, potassium and total carbohydrates percentages of *Alternanthera dentate* plants significantly increased when cultured at 50 cm distance when alternating with *Lettuce capitata* var. *capitata* then replaced with *Coriander sativum* then *lettuce sativa* (Table 9).

Reponses percentage of questionnaire

Data in Tables 11 show that alternating planting method was frequency 20 times with 66.7 % against 10 times for row planting with 33.3%. Moreover, 30 cm planting distance was frequency 22 times with 73.3 % against 8 times for row planting with 26.7% (Table 12). The responses' overall orientation towards the general shape of the presence of several plants together was 26.7 % preferred, 56.7 % to most extent and 16.7 % not preferred (Table 13).

Table 11. Questionnaire analysis of responses toward the best planting method (average of both seasons)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Row planting	10	33.3	33.3	33.3
	Alternating planting	20	66.7	66.7	100.0
	Total	30	100.0	100.0	

Table 12. Questionnaire analysis of responses toward the best planting distance (average of both seasons)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	30 cm	22	73.3	73.3	73.3
	50 cm	8	26.7	26.7	100.0
	Total	30	100.0	100.0	

Table 13. The responses' overall orientation towards the general shape of the presence of several plants together (average of both seasons)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Not Preferred**	5	16.7	16.7	16.7
	Most extent	17	56.7	56.7	73.3
	Preferred	8	26.7	26.7	100.0
	Total	30	100.0	100.0	

Conclusion

According to our findings it is preferable to alternating *Alternanthera dentate* plants with *Centaurea cineraria* replaced with *lettuce sativa* then replaced with *Zinnia elegans* or *Polyanthus rosa* or *Brassica oleracea* var. *Capitata* sub var. *rubra* then replaced by *Zinnia elegans* at 30 cm planting distance for improving plant growth, chemical constituents and landscape use of *Alternanthera dentate* plants.

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تقييم النمو وبعض المكونات الكيميائية والقيمة التنسيقية لنبات الألنترا دينتاتا المنزرع تحت مسافات وطرق زراعة مختلفة مع النباتات العشبية

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أجرى هذا البحث خلال موسمين متتاليين لأعوام 2021/2020 و2022/2021 في مزرعة قسم البساتين التجريبية، كلية الزراعة بمشتهر، جامعة بنها، مصر. كان الهدف من هذا البحث هو دراسة تأثير طرق زراعة مختلفة (الزراعة في صفوف ورجل غراب) ومسافات زراعة مختلفة (30 و50 سم) مع بعض النباتات العشبية ومعاملات التداخل بينهما على النمو والتركيب الكيميائي والقيمة التنسيقية لنبات الألترننثرا دينتاتا لاستخدامه في تنسيق الحدائق العامة. أشارت النتائج التي تم الحصول عليها إلى أن زراعة نبات الشيرانيا ثم استبداله بنبات الخس ثم استبداله بنبات الزينيا على مسافة 30 سم أعطى أعلى القيم في ارتفاع النبات والوزن الطازج للعشب وعدد الأفرع لكل نبات الألترننثرا دينتاتا . تم الحصول على أعلى نسب المئوية لكل من النيتروجين والفسفور والبوتاسيوم والكربوهيدرات الكلية عندما تبادل نبات الألترننثرا دينتاتا (زراعة رجل غراب) مع نبات ورد البوليننثاعلى مسافة 50 سم. أدت زراعة نبات الألترننثرا دينتاتا كعقل مجذرة كزراعة صفوف على مسافة 50 سم إلى زيادة معنوية في عدد الأوراق لكل نبات والوزن الطازج للعشب وعدد الأفرع لكل نبات مقارنة بمعاملات التداخل الأخرى قيد الدراسة. أدى زراعة الكرنب البلدي ثم لها بنباتات الزينيا على مسافة 30 سم للحصول على أعلى القيم في النسب المئوية من النيتروجين والفسفور والبوتاسيوم والكربوهيدرات الكلية لنباتات الألترننثرا دينتاتا. كان الاتجاه العام للاستبيان نحو الشكل العام عند زراعة نباتات الألترننثرا دينتاتا مع النباتات العشبية المختلفة هو موافق بنسبة 26.7%، و إلى حد ما بنسبة 56.7% ، و غير موافق بنسبة16.7%.

الكلمات المفتاحية: الألترننثرا دينتاتا، طريقة الزراعة، المسافة، النمو، المحتوى الكيميائي، القيمة التنسيقية